

WHAT IS CLAIMED IS:

1 1. A structure to generate x-rays comprising:
2 a stationary cathode structure having a plurality of stationary and
3 individually electrically addressable field emissive electron sources defining a
4 plurality of cathodes, each cathode disposed on a first side of the cathode structure;
5 a stationary target structure having a deflection surface oriented
6 non-perpendicularly to the first side of the cathode structure, the deflection surface
7 defining a target;
8 an object positioner disposed within an imaging zone; and
9 a detector operatively positioned within the structure to receive and
10 detect an x-ray from the target,
11 wherein each cathode comprises a substrate and a gate electrode positioned
12 parallel to and insulated from the substrate, the substrate comprising a field emissive
13 material.

1 2. The structure of claim 1, wherein the field emissive material is
2 selected from the group consisting of single walled carbon nanotubes, double walled
3 carbon nanotubes, multi-wall carbon nanotubes, nanotubes comprising at least one
4 non-carbon element, or a nanorod/nanowire comprising at least one of a metal, a
5 metal oxide, silicon, silicon carbide, silicon oxide, carbon nitride, boron nitride,
6 boron carbide, or a chalcogenide.

1 3. The structure of claim 1, wherein each of the plurality of cathodes
2 is a recessed well in the cathode structure and into which the substrate is disposed,
3 and the gate electrode is disposed across the surface of the substrate substantially
4 equidistant from the substrate.

1 4. The structure of claim 1, wherein the plurality of cathodes are each
2 individually positioned on the first surface of the cathode structure at a
3 predetermined interval.

1 5. The structure of claim 4, wherein the predetermined interval is
2 approximately 10° to 120°.

1 6. The structure of claim 1, wherein the target is an area array of
2 target material or a plurality of individual target material.

1 7. The structure of claim 1, further comprising:
2 an evacuated chamber substantially in the form of a hollow cylinder
3 having an inner wall and an outer wall and adapted to position an object to be
4 imaged by the structure within the imaging zone.

1 8. The structure of claim 7, further comprising:
2 a plurality of collimating windows disposed in the inner wall.

1 9. The structure of claim 1, wherein the target is an area array of
2 individual target material or a line array of target material.

1 10. The structure of claim 1, wherein the detector is a stationarily
2 positioned charged-coupled device.

1 11. A method of generating an x-ray image comprising the steps of:
2 positioning an object within an imaging zone;
3 switching each of a plurality of cathodes on a stationary cathode
4 structure at a predetermined frequency to field emit an electron, each of the plurality
5 of cathodes individually addressable and electrically switched in a programmable
6 sequence to field emit electrons toward an incidence point on a stationary target
7 structure, the cathode comprising a field emissive electron source;
8 emitting an x-ray from a target of the stationary target structure at
9 the predetermined frequency;
10 imaging the object; and
11 detecting the emitted x-ray,
12 wherein a position on the stationary target structure from which the x-ray
13 emits corresponds spatially and temporally to a position on the cathode structure
14 from which the electron emits, and
15 wherein at least one of a circumferential position and an elevation angle of
16 the emitted x-ray is sufficiently discriminated with respect to the object to produce a
17 three dimensional image.

1 12. The method of claim 11, wherein the field emissive material is
2 selected from the group consisting of single walled carbon nanotubes, double walled
3 carbon nanotubes, multi-wall carbon nanotubes, nanotubes comprising at least one
4 non-carbon element, and nanorods/nanowires comprising at least one of a metal, a
5 metal oxide, silicon, silicon carbide, silicon oxide, carbon nitride, boron nitride,
6 boron carbide, or a chalcogenide.

1 13. The method of claim 11, wherein the predetermined frequency is in
2 the range of 0.1 Hz to 100 kHz.

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1 14. The method of claim 11, wherein the predetermined frequency is
2 sufficiently rapid to dynamically image a physiological function.

1 15. The method of claim 11, wherein the electron is non-divergent and
2 accelerated from a field emissive material toward a gate electrode and impacts the
3 target at an incidence point.

1 16. The method of claim 11, wherein the step of emitting an x-ray
2 forms a pencil-like x-ray beam, the x-ray beam corresponding to one or more pixels
3 of a detecting means utilized in the step of detecting.

1 17. The method of claim 16, wherein the x-ray beam corresponds to no
2 more than ten pixels.

1 18. The method of claim 11, wherein the step of emitting an x-ray
2 forms a fan-like x-ray beam, the x-ray beam corresponding to one or more lines of
3 pixels of a detecting means utilized in the step of detecting.

1 19. The method of claim 18, wherein the x-ray beam corresponds to a
2 line of no more than ten lines of pixels.

1 20. The method of claim 11, wherein the step of emitting an x-ray
2 forms a cone-like x-ray beam, the x-ray beam corresponding to an area of no more
3 than 128x128 square pixels of a detecting means utilized in the step of detecting.

1 21. The method of claim 20, wherein the x-ray beam corresponds to an
2 area of no more than 64x64 square pixels.

1 22. The method of claim 11, wherein a detecting means used in the step
2 of detecting is a charge-coupled device, the charge-coupled device stationarily
3 positioned to detect the emitted x-ray.

1 23. The method of claim 11, further comprising a step of transferring a
2 detected image resulting from the step of detecting to a computer storage device and
3 refreshing a detecting means for a next image.

1 24. A structure to generate x-rays comprising:
2 a plurality of stationary and individually electrically addressable
3 electron sources defining a plurality of cathodes;
4 at least one target placed opposing the cathodes; and
5 an evacuated chamber that houses the plurality of cathodes and the
6 at least one target.

1 25. The structure of claim 24, wherein the electron sources are field
2 emission electron sources.

1 26. The structure of claim 25, wherein each electron field emission
2 source is a triode-type comprising a field emissive material and a gate electrode
3 positioned parallel to and insulated from a substrate, and

4 wherein a plurality of electrons are field emitted from the cathode when
5 the electric field between the gate electrode and the field emissive material exceeds a
6 threshold value, and

7 wherein the plurality of field emitted electrons pass the gate electrode and
8 are further accelerated to impact on the at least one target by an electric field applied
9 between the gate electrode and the at least one target, and

10 wherein, upon impact, at an incidence point, at least one x-ray having a
11 characteristic wavelength corresponding to a material of the at least one target and at
12 least one x-ray having a continuous wavelength are generated.

1 27. The structure of claim 25, wherein the field emissive material is
2 selected from the group consisting of single walled carbon nanotubes, double walled
3 carbon nanotubes, multi-wall carbon nanotubes, nanotubes comprising at least one
4 non-carbon element, and nanorods/nanowires comprising at least one of a metal, a
5 metal oxide, silicon, silicon carbide, silicon oxide, carbon nitride, boron nitride,
6 boron carbide, or a chalcogenide.

1 28. The structure of claim 25, wherein the field emissive material is
2 coated on the substrate as a film, is embedded in a matrix of the substrate, or is a
3 free-standing substrate structure, and the gate electrode is disposed across a surface
4 of the substrate substantially equidistant from the substrate.

1 29. The structure of claim 24, further comprising:
2 an evacuated chamber with a plurality of x-ray transparent
3 windows, each window positioned to allow the passage of at least one x-ray beam
4 generated by a plurality of electrons from a corresponding one of the plurality of
5 cathodes,

6 wherein the plurality of cathodes and the at least one target are disposed
7 within the evacuated chamber and the evacuated chamber is operationally maintained
8 at a pressure lower than 10^{-3} Torr.

1 30. The structure of claim 24, wherein the plurality of cathodes and the
2 at least one target are each on an opposing plane and the target has a deflection
3 surface that is oriented toward a surface of the plurality of cathodes that emits
4 electrons.

1 31. The structure of claim 30, wherein the deflection surface is
2 oriented non-parallel to the surface of the plurality of cathodes.

1 32. The structure of claim 30, wherein each of the plurality of cathodes
2 are individually positioned on one of the opposing planes at a pre-determined
3 interval.

1 33. The structure of claim 24, wherein the plurality of cathodes are
2 disposed on a first ring and the at least one target is disposed on a second ring, the
3 first and second rings concentric, and the at least one target has a deflection surface
4 that is oriented toward a surface of the plurality of cathodes that emits electrons.

1 34. The structure of claim 33, wherein the deflection surface is
2 oriented non-parallel to the surface of the plurality of cathodes.

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1 35. The structure of claim 33, wherein each of the plurality of cathodes
2 are individually positioned on one of the first or second rings at a pre-determined
3 interval.

1 36. A device to record x-ray images, comprising:
2 an x-ray source comprising a plurality of stationary and
3 individually electrically addressable electron sources defining a plurality of
4 cathodes, the plurality of cathodes disposed on a face of a first planar surface, at
5 least one target disposed on a second planar surface, a deflection surface of the
6 second planar surface opposing the face of the first planar surface, and an evacuated
7 chamber that houses the plurality of cathodes and the at least one target;
8 an array or matrix of x-ray detectors or x-ray sensitive films
9 opposing the x-ray source, the array or matrix substantially parallel to and at equal
10 distance to the x-ray source; and
11 an object positioner placed between the x-ray source and the array
12 or matrix.

1 37. The device of claim 36, wherein the deflection surface is oriented
2 substantially parallel to the face of the plurality of cathodes that emits electrons.

1 38. The device of claim 36, wherein each of the plurality of electron
2 sources are individually positioned at a pre-determined interval on the face of the
3 plurality of cathodes.

1 39. The device of claim 36, wherein the x-ray source further comprises
2 a plurality of x-ray transparent windows disposed in a wall of the evacuated
3 chamber, and a plurality of parallel collimators, at least one parallel collimator on
4 each one of the plurality of x-ray transparent windows.

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1 40. The device of claim 36, wherein the object positioner is movable
2 with respect to the x-ray source.

1 41. The device of claim 36, wherein the detector is a stationarily
2 positioned charged coupled device.

1 42. A method to obtain an x-ray image, the method comprising:
2 placing an object in an x-ray source, the x-ray source comprising a
3 plurality of stationary and individually electrically addressable electron sources
4 defining a plurality of cathodes, the plurality of cathodes disposed on a face of a
5 first planar surface, at least one target disposed on a second planar surface, a
6 deflection surface of the second planar surface opposing the face of the first planar
7 surface, and an evacuated chamber that houses the plurality of cathodes and the at
8 least one target, an array or matrix of x-ray detectors or x-ray sensitive films
9 opposing the x-ray source, the array or matrix substantially parallel to and at equal
10 distance to the x-ray source, and an object positioner placed between the x-ray
11 source and the array or matrix;
12 applying power to at least one of the plurality of cathodes to
13 generate x-ray radiation for a pre-set exposure time;
14 exposing the object to the x-ray radiation; and
15 capturing an x-ray image corresponding to the object by either the
16 x-ray detectors or the x-ray sensitive films.

1 43. The method of claim 42, wherein the power is applied to all of the
2 plurality of cathodes simultaneously.

1 44. The method of claim 42, wherein the power is applied to a subset
2 of the plurality of cathodes sequentially at a pre-set or variably-set frequency.

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1 45. The method of claim 44, further comprising:
2 moving or activating the x-ray detectors or the x-ray sensitive films
3 at a corresponding frequency to the pre-set or variably-set frequency to capture the
4 x-ray image.

1 46. The method of claim 42, wherein a detecting means used in the step
2 of detecting is a charge-coupled device, the charge-coupled device stationarily
3 positioned to detect the emitted x-ray.

1 47. The method of claim 42, further comprising a step of transferring a
2 detected image resulting from the step of detecting to a computer storage device and
3 refreshing a detecting means for a next image.

1 48. A device to record x-ray images comprising:
2 an x-ray source comprising a plurality of stationary and
3 individually electrically addressable electron sources defining a plurality of
4 cathodes, the plurality of cathodes disposed on a surface of a first ring, at least one
5 target disposed on a second ring, a deflection surface of the second ring opposing
6 the surface of the first ring, and an evacuated chamber that houses the plurality of
7 cathodes and the at least one target;
8 an array or matrix of x-ray detectors or x-ray sensitive films on a
9 surface opposing the x-ray source, the array or matrix substantially concentric to
10 and at equal distance to the x-ray source; and
11 an object positioner placed between the x-ray source and the array
12 or matrix.

1 49. The device of claim 48, wherein the first and second ring are
2 concentric.

1 50. The device of claim 48, wherein each of the plurality of electron
2 sources are individually positioned at a pre-determined interval on the surface of the
3 ring.

1 51. The device of claim 48, wherein the x-ray source further comprises
2 a plurality of x-ray transparent windows disposed in a wall of the evacuated
3 chamber a plurality of parallel collimators, at least one parallel collimator on each
4 one of the plurality of x-ray transparent windows.

1 52. The device of claim 48, wherein the object positioner is movable
2 with respect to the x-ray source.

1 53. The device of claim 48, wherein the detector is a stationarily
2 positioned charged coupled device.

1 54. A method to obtain an x-ray image, the method comprising:
2 placing an object in an x-ray source, the x-ray source comprising a
3 plurality of stationary and individually electrically addressable electron sources
4 defining a plurality of cathodes, the plurality of cathodes disposed on a surface of a
5 first ring, at least one target disposed on a second ring, a deflection surface of the
6 second ring opposing the surface of the first ring, and an evacuated chamber that
7 houses the plurality of cathodes and the at least one target, an array or matrix of
8 x-ray detectors or x-ray sensitive films on a surface opposing the x-ray source, the
9 array or matrix substantially concentric to and at equal distance to the x-ray source,
10 and an object positioner placed between the x-ray source and the array or matrix;
11 applying power to all of the plurality of cathodes to generate x-ray
12 radiation for a pre-set exposure time;
13 exposing the object to the x-ray radiation; and
14 capturing an x-ray image corresponding to the object by either the
15 x-ray-detectors-or-the-x-ray-sensitive-films.

1 55. The method of claim 54, wherein the power is applied to all of the
2 plurality of cathodes simultaneously.

1 56. The method of claim 54, wherein the power is applied to a subset
2 of the plurality of cathodes sequentially at a pre-set or variably-set frequency.

1 57. The method of claim 56, further comprising:
2 moving or activating the x-ray detectors or the x-ray sensitive films
3 at a corresponding frequency to the pre-set or variably-set frequency to capture the
4 x-ray image.

1 58. The method of claim 54, wherein a detecting means used in the step
2 of capturing an x-ray image is a charge-coupled device, the charge-coupled device
3 stationarily positioned to detect the x-ray radiation.

1 59. The method of claim 54, further comprising a step of transferring a
2 detected image resulting from the step of capturing an x-ray image to a computer
3 storage device and refreshing a detecting means for a next x-ray image.

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